



Europäisches Patentamt  
European Patent Office  
Office européen des brevets

(11) Publication number:

0 318 598  
A1

(12)

## EUROPEAN PATENT APPLICATION

published in accordance with Art. 158(3) EPC

(21) Application number: 88905428.4

(51) Int. Cl.: F 23 G 5/10, F 23 G 5/00,  
H 05 B 6/80

(22) Date of filing: 16.06.88

Data of the international application taken as a basis:

(86) International application number:  
PCT/JP 88/00586

(87) International publication number:  
WO 88/10399 (29.12.88 88/28)

(30) Priority: 19.06.87 JP 153707/87  
31.06.87 JP 216919/87  
18.12.87 JP 322417/87

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(43) Date of publication of application: 07.06.89  
Bulletin 89/23

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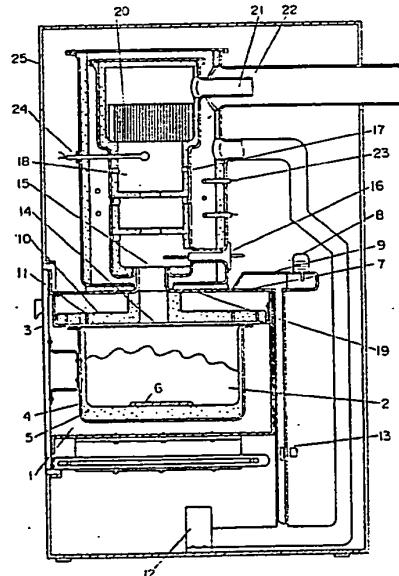
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### (54) MICROWAVE INCINERATOR.

(55) This invention relates to a microwave incinerator for incinerating organic matter having a high water content, such as garbage, by using microwaves. This incinerator consists of a primary combustion chamber (4) in which garbage, an object to be incinerated, is placed, and a secondary combustion chamber (18) in which a gas of the decomposed garbage (2) is burnt. In the chamber (4), the garbage (2) is decomposed or carbonized by microwaves and, in the chamber (18) in which microwaves are not radiated, the decomposition gas is burnt by an igniter. The incinerator of the above-described construction has the following characteristics. The garbage is dried by microwaves into a high-quality fuel, which is then decomposed and completely burnt. Accordingly, the waste gas from the incinerator is clean. Since the garbage can be reduced into ashes completely at a high temperature, the incineration of the garbage can be carried out sanitorily. This invention relates to a structure, a control method and a material required for a novel microwave incinerator. These essential elements enable the above-described operations.

EP 0 318 598 A1



00318598

- 1 -

SPECIFICATION

TITLE OF THE INVENTION

Electronic incinerating apparatus

TECHNICAL FIELD

5       The present invention relates to an electronic incinerating apparatus which is a combination of a microwave apparatus and a combustion apparatus and can cleanly incinerate garbage at very high temperatures, and this apparatus can solve the problem of uncleanliness,  
10 putrefaction and dirtiness of garbage, and is used particularly for treatment of garbage at a place such as a country house where sewage system is not complete or for treatment of dangerous filth produced by a hospital or biologic researchers.

15 BACKGROUND ART

In general, to treat garbage, so far the treating apparatuses have been used which crush garbage with a rotary blade called disposer and throw it away in sewage.

The disposer has a simple structure, while it discharges  
20 a large amount of solids into drainage, and therefore it is likely to cause stopping-up of sewage, and some countries prohibit the use of such an apparatus from the point of environmental pollution. Also, in hospitals, research

00318598

- 2 -

institutes and the like, ordinary treatment of garbage is prohibited for sanitary reasons.

On the other hand, the combustion type treating apparatus is sanitary because it completely decomposes 5 organic matters. In this method, fuel is burned by burners and garbage is treated by incinerating it by combustion heat of the fuel, and therefore this method has features of remarkably reducing the residual amount of treatment and causing disease germs and the like to perfectly perish, while 10 it has major defects such that the structure is complicated, the apparatus becomes large-sized, smoke and bad smell are likely to be produced, and environmental pollution is caused. On the other hand, the method using electricity can employ an apparatus which is small-sized, easy to handle and excellent 15 in controllability. However, the heater-heating system using resistance wires, although it is a system using electricity, is low in the incinerating temperature, and cannot carry out a satisfactory incineration. Accordingly, this system is difficult to burn garbage completely to ashes even if it can 20 sterilize, and therefore it is not suitable for practical use. On the other hand, the method using microwave can incinerate garbage at high temperatures, and therefore it has a feature that the garbage treatment can be carried out 25 perfectly. However, in the microwave incinerating system, the temperature of the generated flame becomes extra-

ordinarily high, and an abnormal combustion or a damage of the apparatus is likely to be caused, and therefore it is difficult to be used also for a combustion apparatus. For this reason, the apparatuses using microwave have not 5 propagated generally.

#### DISCLOSURE OF INVENTION

An object of the present invention is to provide a treating apparatus having a small size and a simple constitution which suppresses generation of smoke and smell 10 in incinerating garbage, thereby causing no environmental pollution.

The above-mentioned object of the present invention can be achieved by the following constitution. This means that an apparatus of the present invention comprises a primary 15 combustion chamber for storing matters to be burned, means for supplying air for combustion to the above-mentioned primary combustion chamber, a microwave generating source connected to the above-mentioned primary combustion chamber through a waveguide, a secondary combustion chamber installed 20 downstream from the above-mentioned primary combustion chamber, igniting means installed in the above-mentioned secondary combustion chamber, a microwave shield plate installed between the above-mentioned primary combustion chamber and the above-mentioned secondary combustion chamber,

and a gas passage part open to the above-mentioned microwave shield plate.

The apparatus of the present invention is constituted as described above, and dries garbage by means of microwave to change it into fuel having a high quantity of heat, and thereafter decomposes organic matters by microwave to achieve a perfect combustion, and therefore the combustion temperature is high. Also, it has an excellent controllability of the quantity of combustion, can quickly increase or decrease the quantity of gas decomposition under control of microwave, can keep the ratio of air to fuel at combustion constant, and therefore can keep an optimum combustion temperature.

Furthermore, carbonized matter having lost gasified components causes a discharge spark by microwave, and this spark causes the carbonized garbage to burn. In addition, garbage contains components such as potassium and sodium which are easy to be put in the plasma state, and therefore this flame is easy to receive microwave and become high-temperature plasma. The garbage is completely burned out by this action, and only a minute amount of incombustible ash remains.

Thus, according to the constitution of the present invention, the object of realizing an apparatus which, by perfectly burning garbage, eliminates an extraordinarily

00318593

- 5 -

excessive combustion, bad smell or sanitary problems due to dirtiness of the apparatus can be achieved.

BRIEF DESCRIPTION OF DRAWING

Fig. 1 is a cross-sectional view of one embodiment of an electronic incinerating apparatus in accordance with the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Fig. 1 is a cross-sectional view showing one embodiment of the present invention, and in Fig. 1, numeral 1 designates 10 a storing chamber for garbage 2 to be burned. At the front of the storing chamber 1, a door 3 is installed which can slide back and forth by means of rails. The garbage 2 is put in a dish-shaped primary combustion chamber 4 installed in the storing chamber 1. This primary combustion chamber 4 is 15 fixed to the door 3. Also, a microwave absorber 6 such as silicon carbide or zirconia is installed at the bottom part of the primary combustion chamber 4 through an adiabatic material 5. Also, an opening 7 at the top of the storing chamber 1 communicates with an oscillating part of a 20 magnetron 8 through a waveguide 9.

Also, air holes 11 are installed in a top lid 10 installed at the top of the storing chamber 1. Air for combustion is supplied to these air holes 11 by a blower 12

00318593

- 6 -

and a damper 13. A gas introducing hole 14 is installed at nearly the center of the top lid 10. Downstream from the storing chamber 1, a gas passage part 15 communicating with the gas introducing hole 14, an igniting heater 16, and a 5 secondary combustion chamber 18 having combustion holes 17 are installed. The gas passage part 15 has a cylindrical shape of a diameter of one-fourth or less of the wavelength of microwave and a length of one-fourth or more of the wavelength thereof, and is constituted so that gas can pass 10 therethrough, but microwave cannot penetrate therethrough. Also, the secondary combustion chamber 18 is partitioned completely from the primary combustion chamber 4 by a microwave shield plate 19 except for the gas passage part 15. Combustion air is sent to the combustion holes 17 of the 15 secondary combustion chamber from the above-mentioned blower 12. Downstream from the secondary combustion chamber 18, a catalyzer 20, an exhaust hole 21 and an exhaust gas diluting part 22 are disposed. Also, heaters 23 are installed upstream from the combustion holes 17 in the side wall of the 20 secondary combustion chamber 18. Also, a combustion temperature detecting part 24 for detecting the combustion temperature is installed in the upper part of the secondary combustion chamber 18. Then, the apparatus thus constituted 25 is enclosed with a case 25, and the side part of the apparatus is fixed to the case 25.

00318590

- 7 -

Hereinafter, description is made on operation of the apparatus of the present invention having the constitution as described above.

By pulling out the door 3 forth, the primary combustion chamber 4 can be taken out forward. The garbage 2 is put into the primary combustion chamber 4, and is set again in the storing chamber 1.

Next, drying is started by oscillation of the magnetron 8 and operation of the blower 12. Microwave of 2450 MHz from the waveguide 9 passes through the adiabatic top lid 10 made of microwave-permeable ceramic fibers, and generates a high electric field in a microwave-resonation space formed by the upper part of the storing chamber 1 and the primary combustion chamber 4. This microwave has a wavelength of 12 15 cm, and the diameter of the gas passage part 15 is set to 3 cm or less, and therefore this microwave does not go out of this gas passage part 15. Also the microwave reflects on a metal wall, and therefore almost all thereof is absorbed by moisture in the garbage 2. For this reason, the garbage 2 is dried quickly. Also at the same time, with the progress of drying of the garbage 2, the microwave absorber 6 begins to absorb the microwave and the temperature thereof becomes high, and the garbage 2 is dried also from the bottom part of the primary combustion chamber 4 by the heat of this microwave absorber 6. When moisture is removed, the microwave

00318593

- 8 -

starts to heat the garbage, and decomposes the garbage 2 and generates gas. This gas passes through the gas passage part 15 and enters the secondary combustion chamber 18. The igniting heater 16 installed in the secondary combustion chamber 18 ignites the gas when the gas density in the secondary combustion chamber 18 increases gradually and the gas becomes inflammable.

Until the gas is ignited, moisture generated in the primary combustion chamber 4 is discharged through the secondary combustion chamber 18. At this time, if the secondary combustion chamber 18 contains moisture, a soot choking is caused in the gas passage part 15, or a poor ignition, a reduction in the combustion temperature or a generation of bad smell is caused due to a large latent heat of water. Particularly, if the ignition portion gets wet, the temperature thereof is reduced, and the relative density of the decomposition gas is reduced and the ignition becomes difficult. In the present invention, during the period of drying of this garbage 2, air is heated by the heaters 23, 20 and this air is transferred through a secondary air tube 25(sic), and thereby the ignition part and the whole of the secondary combustion chamber 18 are heated so as not to get wet. At the same time, the heaters 23 raise the temperature of the catalyzer 20 to the activating temperature thereof to prevent a generation of bad smell. Also, the flame in the

00318590

- 9 -

secondary combustion chamber 18 is extinguished in the gas passage part 15 because the decomposition gas generated in the primary combustion chamber 18(sic) blows out upward (secondary combustion chamber 18), and does not spread to the 5 primary combustion chamber 4. To enhance this extinguishing effect, a wire net or a porous body can be installed in the gas passage part 15. When combustion is performed in the secondary combustion chamber 18, the garbage 2 which is fuel has been already dried, and therefore the catalyzer is not 10 poisoned by moisture, the activity thereof is maintained and no bad smell is generated.

During the combustion of the decomposition gas in the secondary combustion chamber 18, the quantity of combustion is detected by the combustion temperature detecting part 24, 15 and the microwave is controlled to suppress the quantity of combustion so as not to increase beyond the combustion capacity of this secondary combustion chamber 18.

At this time, air for combustion of 1--10% of that to the secondary combustion chamber 18 is sent to the primary 20 combustion chamber 4. The amount of air smaller than this range is difficult to transfer the generated decomposition gas to the secondary combustion chamber 18, and bad smell sometimes escapes outside from the storing chamber 1. And, if the amount of air is larger than this range (1--10%), the 25 garbage 2 in the primary combustion chamber 4 is decomposed

by the combustion heat of the garbage itself, and the control of the quantity of combustion by the control of the microwave cannot be performed.

The microwave is shielded by the microwave shield plate 5 19 so as not to enter the secondary combustion chamber 18 where high-temperature combustion is performed. The flame is ionized at high temperatures, and therefore if receiving the microwave, it would be put in a plasma state and the temperature thereof becomes extremely high; but such a 10 phenomenon does not take place in the secondary combustion chamber 18, and the constituent materials of the equipment are never melted. On the other hand, the primary combustion chamber is irradiated by the microwave, but when the garbage 2 is decomposing gasified components the amount of air is 15 limited as described above, and therefore the amount of high-temperature flame is small, and an extremely large plasma is not generated. Accordingly, a breakage of the constituent material of the equipment does not occur.

Also, to prevent the gas passage part 15 from being 20 choked with soot during combustion of the decomposition gas, the cylindrical tip is extended to the secondary combustion chamber 18, and the gas passage part 15 is kept at high temperatures by the heat of the secondary combustion chamber 18; and therefore the soot having adhered to the gas passage 25 part 15 can be incinerated.

The apparatus of the present invention gasifies and burns components easy to be gasified by such a system; but with the progress of carbonization of the garbage 2, generation of gas is weakened.

5 This state is judged by the change in the combustion temperature, and by operating the damper 13, a large amount of air is sent to this carbonized matter to burn it to ashes. This change in the combustion temperature appears remarkably because the flame moves downward from the secondary 10 combustion chamber 18 to the primary combustion chamber 4 when the garbage 2 loses gasification components. In and after this state, since the garbage 2 has already lost the decomposition gas, an excessive combustion is not performed even if a large amount of air is sent to the primary 15 combustion chamber 4, and carbonizing combustion which is surface combustion starts, and the carbonized matter is heated in red.

In such a state, the microwave from the magnetron 8 generates discharge at the carbonized portion of the garbage 20 2, and the flame becomes a plasma state and accelerates the combustion of this carbon.

At the same time, the microwave absorber 6 also receives the microwave, and the temperature thereof becomes high and helps this combustion. Particularly, in the last of burning 25 to ashes when the carbonized matter has been decreased, the

combustion is continued by the heat of this microwave absorber 6. This microwave absorber 6 is installed on the bottom surface of the primary combustion chamber 4 with the adiabatic material or an air layer therebetween to prevent 5 this heat from escaping outside the primary combustion chamber 4.

For the material of such a microwave absorber 6, silicon carbide, silicon nitride, and zirconia, particularly zirconia whereto yttria is added are preferably used which show high 10 ion conductivities. These materials not only have high heat resistances and corrosion resistances, but also are hard to absorb microwave because of low temperatures at drying; and the garbage 2 is never scorched in the state of containing much moisture. On the other hand, they are easy to absorb 15 microwave when burning to ashes, and therefore has a property of becoming high temperatures and maintain the combustion temperatures.

At this time of burning to ashes, the primary combustion chamber 4 becomes the highest temperature. Here, in the 20 present invention, since a large amount of air for the primary combustion is sent to the upper part of the top lid 10, it is prevented from becoming high temperatures.

The above is for the sake that, when the top lid 10 made of refractory ceramics such as alumina or silica becomes high 25 temperatures, the ion conductivity of this material is

increased, and penetration of the microwave is hindered, and the top lid 10 becomes high temperatures due to absorption of the microwave, resulting in a breakage.

In the apparatus of the present invention constituted 5 and operated in such a manner, the reason why bad smell is hard to be generated is as follows.

The gas generated inside the primary combustion chamber 4 is almost a component not burnt yet, and is bad-smelling and extremely heavy.

10 The molecular weight of the generated gas is sometimes large by polymerization, and the gas is in a misty state, therefore being 5--12 times heavier than air.

Thus, the heavy gas can be transferred to the secondary chamber 18 by means of the light air for combustion without 15 leaking outside. That is, the primary combustion chamber 4 is pressurized with the air for combustion in the storing chamber 1 to prevent the gas from flowing out, and air is fed from surroundings so as to envelop the gas in the first combustion chamber 4, and the gas flows out through the gas 20 introducing hole 14 of the central upper part. In this constitution, the heavy gas can only stay below or ascend through the center of the primary combustion chamber 4 to go to the gas introducing hole 14, and therefore the gas is hard 25 to escape from a clearance between the upper part of the primary combustion chamber 4 and the top lid 10.

00319598

- 14 -

Further, the interior of the primary combustion chamber 4 becomes extremely high temperatures. Particularly, when the combustion heat at burning to ashes is added, the temperature thereof reaches nearly 1000°C. Radiation of this heat 5 eliminates all of contamination of the upper part of the primary combustion chamber 4 and contamination of the top lid 10.

#### INDUSTRIAL APPLICABILITY

As described above, the apparatus of the present 10 invention is made as a complex of the primary combustion chamber provided with a magnetron and the secondary combustion chamber consisting of an incinerator burning the gas coming from the primary combustion chamber, and therefore can incinerate garbage cleanly at super high temperatures, 15 can solve the problem of uncleanliness, contamination and dirtiness of garbage, and thereby it having a great value in practical use.

## CLAIMS

1. An electronic incinerating apparatus comprising a primary combustion chamber for storing matters to be burned, means for supplying air for combustion to said first combustion chamber, a microwave generating source connected to said primary combustion chamber through a waveguide, a secondary combustion chamber installed downstream from said primary combustion chamber, igniting means installed in said secondary combustion chamber, a microwave shield plate 10 installed between said primary combustion chamber and said secondary combustion chamber, and a gas passage part open to said microwave shield plate.
2. An electronic incinerating apparatus in accordance with claim 1, wherein the gas passage part and the igniting means 15 and a heater heating the igniting means are installed in a combustion air path of the secondary combustion chamber.
3. An electronic incinerating apparatus in accordance with claim 1, which has a constitution that the gas passage part is cylindrically shaped, the inner diameter thereof is set to 20 one-fourth or less of the wavelength of microwave, the length thereof is set to one-fourth or more of the wavelength of microwave, and the tip thereof is projected into the secondary combustion chamber.
4. An electronic incinerating apparatus in accordance with 25 claim 1, which has a constitution that the primary combustion

00318598

- 16 -

chamber is a dish-shaped vessel, microwave is irradiated onto garbage through a microwave-permeable top lid installed above said primary combustion chamber, and a gas introducing hole installed in said top lid communicates with the secondary 5 combustion chamber.

5. An electronic incinerating apparatus in accordance with claim 1, wherein a combustion temperature detecting part is installed in the secondary combustion chamber, and the output of microwave and the amount of air for combustion are 10 controlled by a signal from said combustion temperature detecting part.

6. An electronic incinerating apparatus in accordance with claim 1, wherein a microwave absorber is installed at the bottom part of the primary combustion chamber.

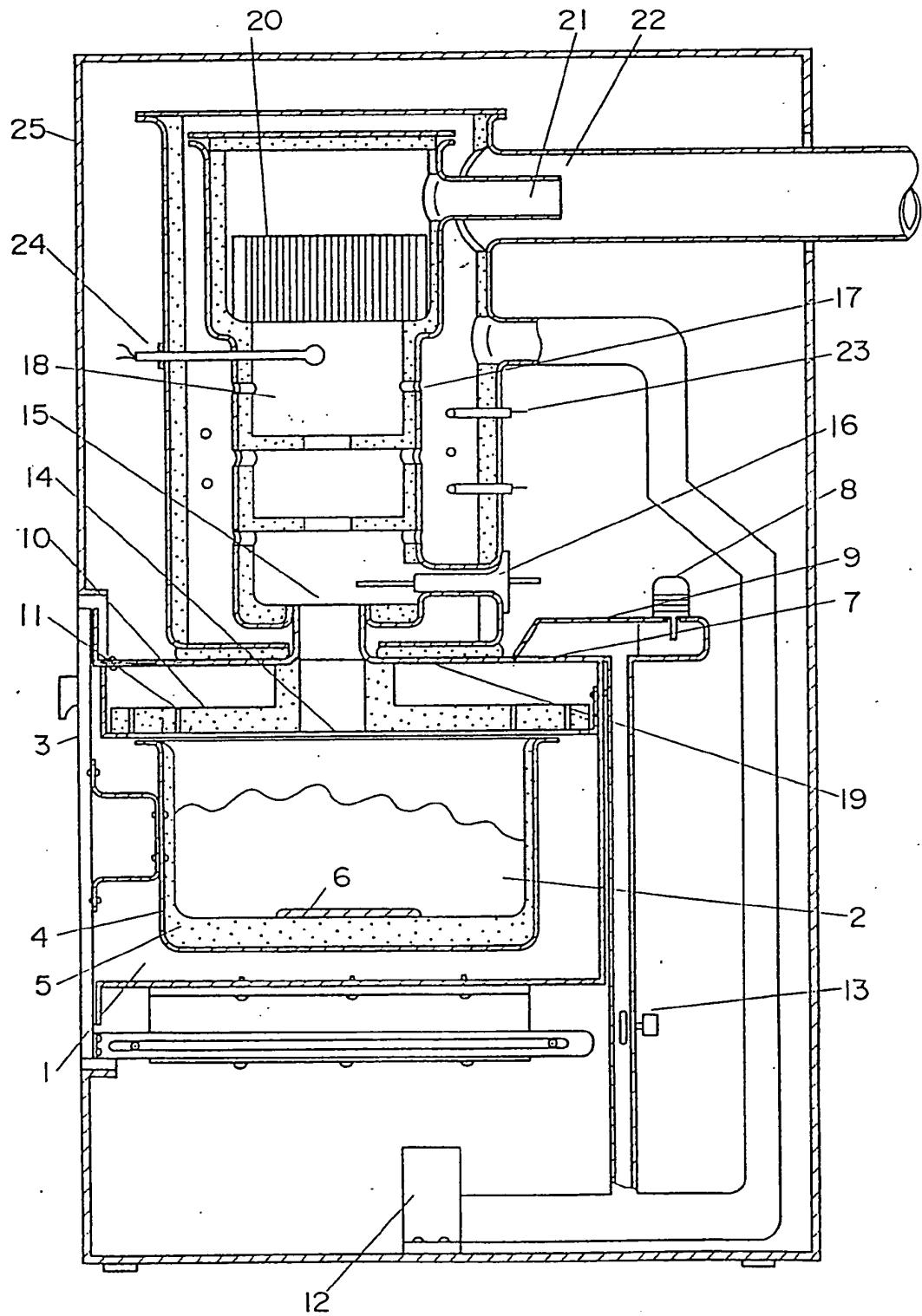
15 7. An electronic incinerating apparatus in accordance with claim 6, wherein an adiabatic layer is installed between the bottom part of the primary combustion chamber and the microwave absorber.

8. An electronic incinerating apparatus in accordance with 20 claim 6, wherein the microwave absorber contains any one of zirconia, silicon carbide and silicon nitride.

00319598

—1/2—

FIG. I



00319598

- 2/2 -

LIST OF REFERENCE NUMBERS IN DRAWING

- 1 ..... a storing chamber
- 2 ..... garbage
- 3 ..... a door
- 5      4 ..... a primary combustion chamber
- 5 ..... an adiabatic material
- 6 ..... a microwave absorber
- 7 ..... an opening
- 8 ..... an oscillating part
- 10     9 ..... a waveguide
- 10 ..... a top lid
- 11 ..... an air hole
- 12 ..... a blower
- 13 ..... a damper
- 15     14 ..... a gas introducing hole
- 15 ..... a gas passage part
- 16 ..... an igniting heater
- 17 ..... a combustion hole
- 18 ..... a secondary combustion chamber
- 20     19 ..... a microwave shield plate
- 20 ..... a catalyzer
- 21 ..... an exhaust hole
- 22 ..... an exhaust diluting part
- 23 ..... a heater
- 25     24 ..... a combustion temperature detecting part

## INTERNATIONAL SEARCH REPORT

00318598

International Application No PCT/JP88/00586

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl<sup>4</sup> F23G5/10, F23G5/00, H05B6/80

## II. FIELDS SEARCHED

Minimum Documentation Searched

Classification System	Classification Symbols
IPC	F23G5/00, F23G5/10, F23G5/027 H05B6/80, F23G6/76

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields SearchedJitsuyo Shinan Koho 1962 - 1988  
Kokai Jitsuyo Shinan Koho 1971 - 1988

## III. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of Document, if with indication, where appropriate, of the relevant passages	Relevant to Claim No.
Y	JP, A, 62-94717 (Matsushita Seiko Co., Ltd.) 1 May 1987 (01. 05. 87)	1-8
Y	JP, U, 61-110948 (Ebara Corporation) 14 July 1986 (14. 07. 86) (Family: none)	1-8
Y	JP, A, 57-184821 (Tokyo Denshi Giken Kabushiki Kaisha) 13 November 1982 (13. 11. 82) Page 99, Drawing (Family: none)	2
Y	JP, A, 57-184832 (Tokyo Denshi Giken Kabushiki Kaisha) 13 November 1982 (13. 11. 82) Page 147, Drawing (Family: none)	2
Y	JP, A, 51-72765 (Matsushita Electric Ind. Co., Ltd.) 23 June 1976 (23. 06. 76) (Family: none)	3

\* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "C" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search

September 6, 1988 (06. 09. 88)

Date of Mailing of this International Search Report

September 19, 1988 (19. 09. 88)

International Searching Authority

Japanese Patent Office

Signature of Authorized Officer

## FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

Y	JP, A, 58-133817 (Brother Industries, Ltd.) 9 August 1983 (09. 08. 83) Page 89, upper right column, line 18 to lower left column, line 3 (Family: none)	5
Y	JP, A, 61-253792 (Ebara Corporation) 11 November 1986 (11. 11. 86) Page 477, upper right column, line 20 to lower left column, line 4 (Family: none)	6-8

V.  OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE<sup>10</sup>

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons

1.  Claim numbers..... because they relate to subject matter<sup>11</sup> not required to be searched by this Authority, namely:

2.  Claim numbers..... because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out<sup>12</sup>, specifically:

VI.  OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

This International Searching Authority found multiple inventions in this international application as follows

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
3.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:
4.  As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

## Remark on Protest

- The additional search fees were accompanied by applicant's protest
- No protest accompanied the payment of additional search fees

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